INSTRUMENT SHOP

INSTRUCTION MANUAL FOR
MODEL P-4214A WIDEBAND RECORDER/REPRODUCER SYSTEM

July 1964

MP MASTER
MA30046

FAIRCHILD
WINSTON RESEARCH
CORPORATION
A SUBSIDIARY OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

INSTRUCTION MANUAL FOR
MODEL P-4214A WIDEBAND RECORDER/REPRODUCER SYSTEM

July 1964

Prepared For
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This is a temporary manual and certain material has not been included. This manual will be replaced by a more complete and up-to-date manual as soon as it becomes available.

SECTION 1. GENERAL

1-1. FUNCTION AND USE

1-2. The Winston Model P-4214A (Figure 1-1) is a wideband magnetic tape recorder/reproducer. It is used to record and monitor signals in the form of analog voltages originating from other equipment, and to reproduce the signals so recorded. The system is bi-directional, i.e., meets all performance specifications in both directions. The transport handles 1-inch-wide tape on 10-1/2-inch NAB precision reels. A total of fourteen tracks are available. These may be utilized simultaneously (forward direction only) or in passes of two or four tracks during automatic series-sequence operation (forward on one pass, reverse direction on the following pass). Tape speeds of 7-1/2, 15, and 60 ips (inches per second) can be selected. At a tape speed of 60 ips, the data signal response is within ±3 db from 400 cps to 1.0 mc. At each tape speed, the appropriate equalizer circuit is automatically connected to the reproduce electronics. Any two tracks may be selected for simultaneous reproduction. Forward or reverse direction may be used to reproduce a recording. Provision is made for connecting external equipment (such as an oscilloscope or vacuum tube voltmeter) to monitor the signal while recording in the forward direction of tape motion.

1-3. DESCRIPTION

1-4. The wideband recorder/reproducer is designed for mounting in a standard 19-inch rack. It occupies a height of 24-1/2 inches.* The system is operated from a nominal 115-volt, 60-cps primary power source.

1-5. The system uses a dual-drive capstan arrangement with associated servo electronics, to maintain a constant tape speed. In the capstan area, tape tension is maintained by a differential in angular velocities of the capstan shafts. A trough guide on the pinch roller arms prevents tape skew and side motion past the heads. The head assembly consists of four head stacks (two record and two reproduce), with seven tracks on each stack. Each set (one record and one reproduce) of head stacks is mounted so the tracks are interlaced, i.e., one set has odd-numbered tracks and the other set has even-numbered tracks.

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*A remote control unit.

FIGURE 1-1. WINSTON MODEL P-4214A RECORDER/REPRODUCER SYSTEM, OVERALL FRONT VIEW

1-6. An electrostatic tachometer, driven by the capstan motor, provides one input signal to an electronic servo system. To maintain absolute tape speed, the electronic servo is phase-locked to a precision oscillator.

1-7. Welded modules are used in the data electronics section of the unit. This type of construction makes possible a compact form factor and provides for ease of troubleshooting and maintenance.

1-8. The system includes a remote control unit from which tape motion (but not tape speed) can be controlled. The tape speed selected at the recorder/reproducer is also indicated by the lighting of related indicators on the remote control unit. A meter on the remote control unit indicates the amount of tape remaining on the supply reel for any given pass.

SECTION 2. SPECIFICATIONS

2-1. Table 2-1 lists the specifications for the Winston Model P-4214A Magnetic Tape Recorder/ Reproducer. These specifications are predicated on the use of 3M-951 magnetic tape wound on precision reels and testing in accordance with Winston test procedures.

TABLE 2-1

MODEL P-4214A SPECIFICATIONS

CHARACTERISTIC	SPECIFICATION
GENERAL	
Temperature:	Operating: 32° to 130°F (0° to 50°C) Non-operating: -79.6° to +167°F (-62° to 75°C).
Humidity:	95% relative, without condensation.
Vibration:	per MIL-STD-167, Type 1 test.
Shock:	15g for 11 milliseconds, once on each axis in each direction (total of six times).
RFI:	Per MIL-I-16910A.
Operating Power:	115 ± 10 volts, 60 ± 3 cps, 300 watts (maximum).
Signal Connectors:	Type BNC coaxial.
Power Connector:	MS3112E12-3P.
Size:	24-1/2" high x 19" wide x 9" deep.
Weight:	92 lbs.
TAPE TRANSPORT	
Tape Speed:	7-1/2, 15, and 60 ips selectable from front panel.
Tape Speed Accuracy:	±0.20% from beginning of reel to end of reel.
Wow and Flutter:	0.3% peak-to-peak, cumulative from 0.1 cps to 10 kc at 60 ips without vibration; 0.6% peak-to-peak, cumulative from 0.1 cps to 10 kc at 60 ips under specified vibration.

TABLE 2-1 (continued)

CHARACTERISTIC	SPECIFICATION
Reel Size:	10-1/2-inch NAB precision reels.
Tape Size:	1-inch wide 1.0 mil polyester base (3M-951 or equivalent).
Recording Time:	12 minutes at 60 ips (one pass).
Start Time:	Less than 6 seconds from actuating the DR switch until tape speed reaches 60 ips and system meets all specifications.
Stop Time:	Not more than 3 seconds.
Reversal Time:	Not more than 10 seconds at 60 ips from the time the recorder/reproducer is sequenced, switches to the next set of tracks, restarts in the opposite direction, and meets all performance specifications.
Bi-directional Operation:	Meets performance specifications in both directions.
Rewind Time:	Less than 4 minutes for 3600 feet of tape.
End-of-tape Sensing:	Tape transport will stop automatically at end of a reel of tape or if tape breaks.
Number of Tracks:	Record: Total of 14 tracks available. Can be used as follows: 14 tracks simultaneously in forward direction, followed automatically by same number of tracks in reverse direction. Number of tracks used is selectable only from local control panel. Automatic sequence can be overridden from either local or remote control panel.
MAGNETIC HEADS	
Track Dimensions & Spacing:	Track dimensions and track spacing conform to IRIG specifications. Gap Azimuth: Record heads held within ±1 minute perpendicular to the head base plate. Reproduce heads adjustable within a range of ±1 degree of nominal azimuth. Gap Scatter: Trailing edges held within a line ±50 micro-inches wide.
Replacement:	Each individual head stack can be separately replaced in the field without any special tools or optical aligning equipment.
DIRECT RECORD/ REPRODUCE SYSTEM	
Frequency Response: (for each speed)	±3 db 400 cps to 1.0 mc at 60 ips.

TABLE 2-1 (continued)

CHARACTERISTIC	SPECIFICATION
	400 cps to 0.225 mc at 15 ips. 400 cps to 0.100 mc at 7-1/2 ips.
Signal-to-Noise Ratio:	23 db (minimum) peak signal-to-rms noise, 400 cps to 1.0 mc bandwidth at 60 ips.
Harmonic Distortion:	3% (maximum) overall of a 1 kc signal recorded at 60 ips.
Input Impedance:	91 ohms.
Input Level:	0.1 to 10 volts.
Output Level:	1 volt rms output into specified output impedance, with reserve gain capability of 12 db for use with low-level input signals.
Output Impedance:	91 ohms.
Phase Response:	Linearity controlled by equalization.

SECTION 3. INSTALLATION

3-1. GENERAL

3-2. This section provides information necessary for unpacking and mounting the system, fabricating the cables required for operation, and making the power, signal, and remote control connections.

NOTE

Because of the weight of the equipment, it is advisable to have two men available to remove the system from the shipping container.

3-3. UNPACKING

3-4. As with all electronic equipment, use care when removing the Winston Model P-4214A Recorder/Reproducer System from its shipping container. Keep the container upright as marked. Open the container and remove the two nuts from each of four spring-loaded carriage bolts that secure the plywood base to the bottom of the container. Carefully remove the system along with the plywood base and remove the bolts that secure the system. Inspect the unit for any possible damage incurred during shipment and report any such damage to the carrier. Save all the packing materials, including the shipping container, for use if the system is to be reshipped.

3-5. MOUNTING

3-6. The Winston Model P-4214A Recorder/Reproducer System is designed to be mounted in a standard 19-inch EIA rack. The system rests on four Grant microslides that allow easy access to the cables at the rear of the case. Eight Southco captive fasteners with 10-24 threads secure the case to the rack frame. Two men should install the equipment in the rack. When installing the system in the rack, be sure that all case slides engage the corresponding rack slides simultaneously. Secure the system to the rack by tightening the eight captive 10-24 screws on the case (four on each side).

3-7. SIGNAL CONNECTIONS

3-8. All input (data record) and output (reproduce) signal connections are made through BNC-type connectors at the rear of the system (Figure 3-5). Fabricate input and output signal cables

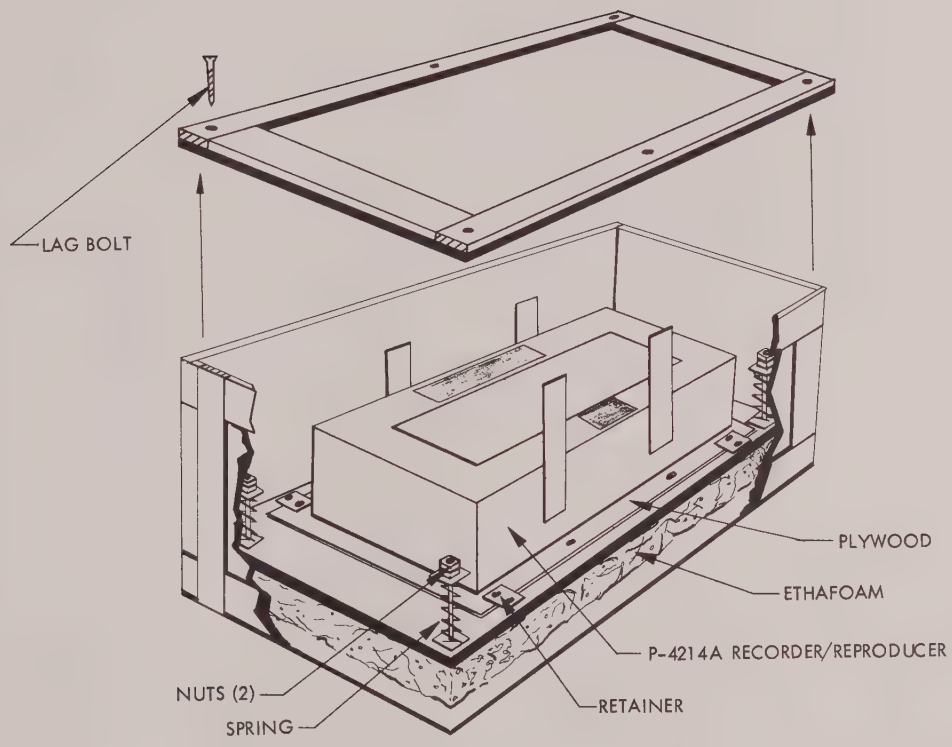


FIGURE 3-1. UNPACKING THE WINSTON P-4214A RECORDER/REPRODUCER SYSTEM

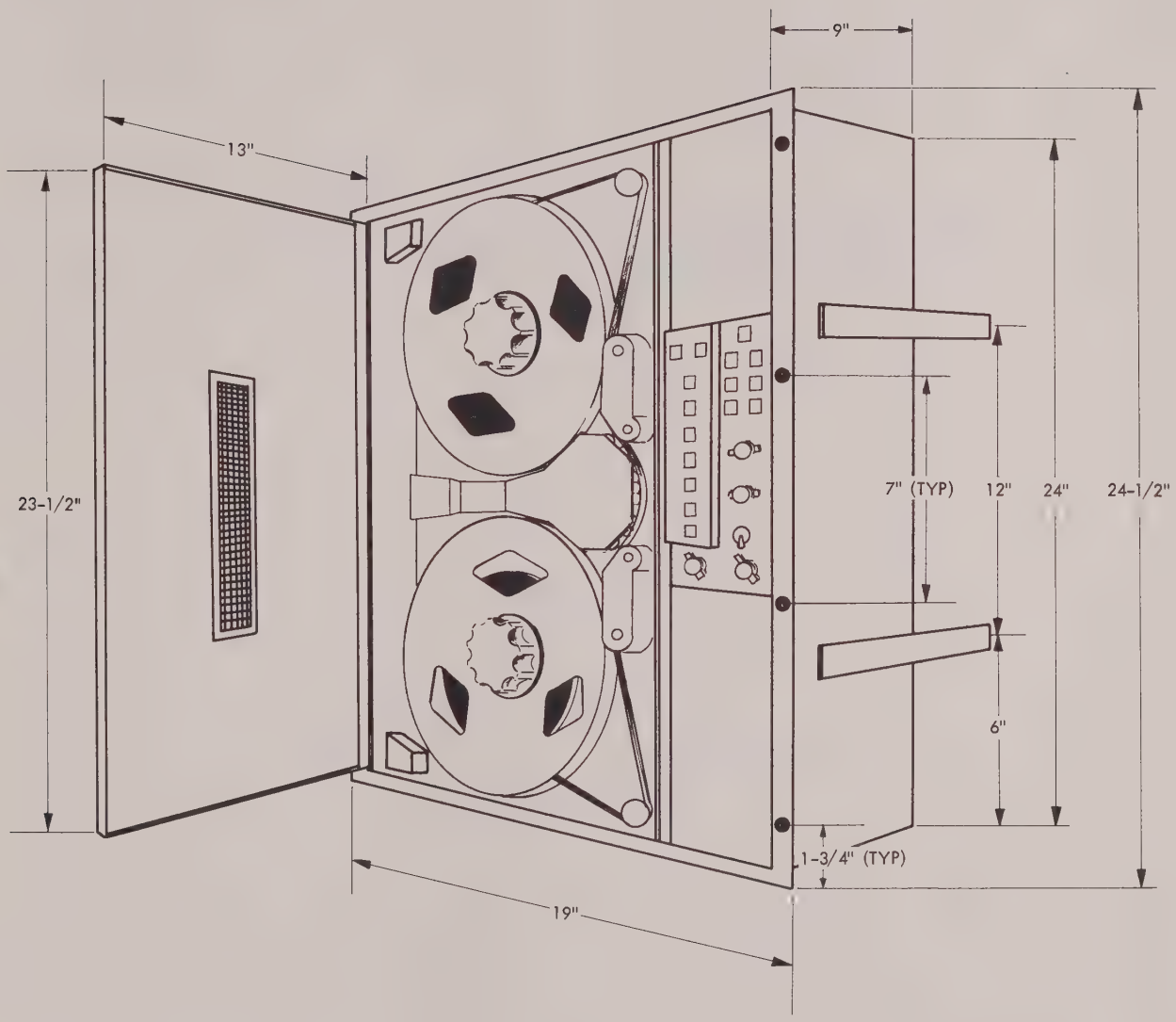
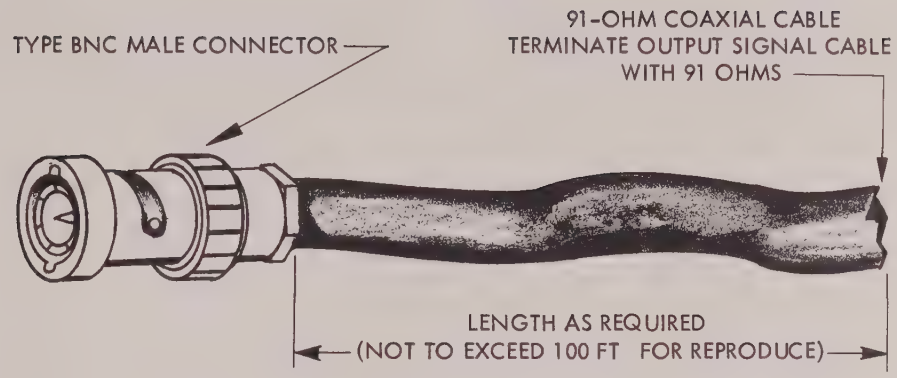
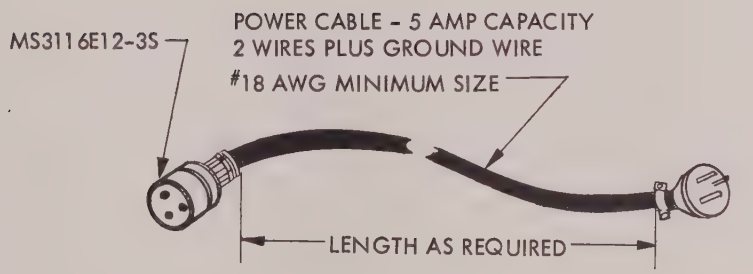


FIGURE 3-2. OUTLINE DIMENSIONS


TYPE BNC MALE CONNECTOR
91-OHM COAXIAL CABLE
TERMINATE OUTPUT SIGNAL CABLE
WITH 91 OHMS
LENGTH AS REQUIRED
(NOT TO EXCEED 100 FT FOR REPRODUCE)

A. SIGNAL CABLE



NOTE: CHOOSE POWER CABLE SO VOLTAGE DROP DOES NOT EXCEED 5 VOLTS AT A LOAD OF 5 AMPERES

B. POWER CABLE

FIGURE 3-3. DIAGRAMS OF SIGNAL AND POWER CABLES

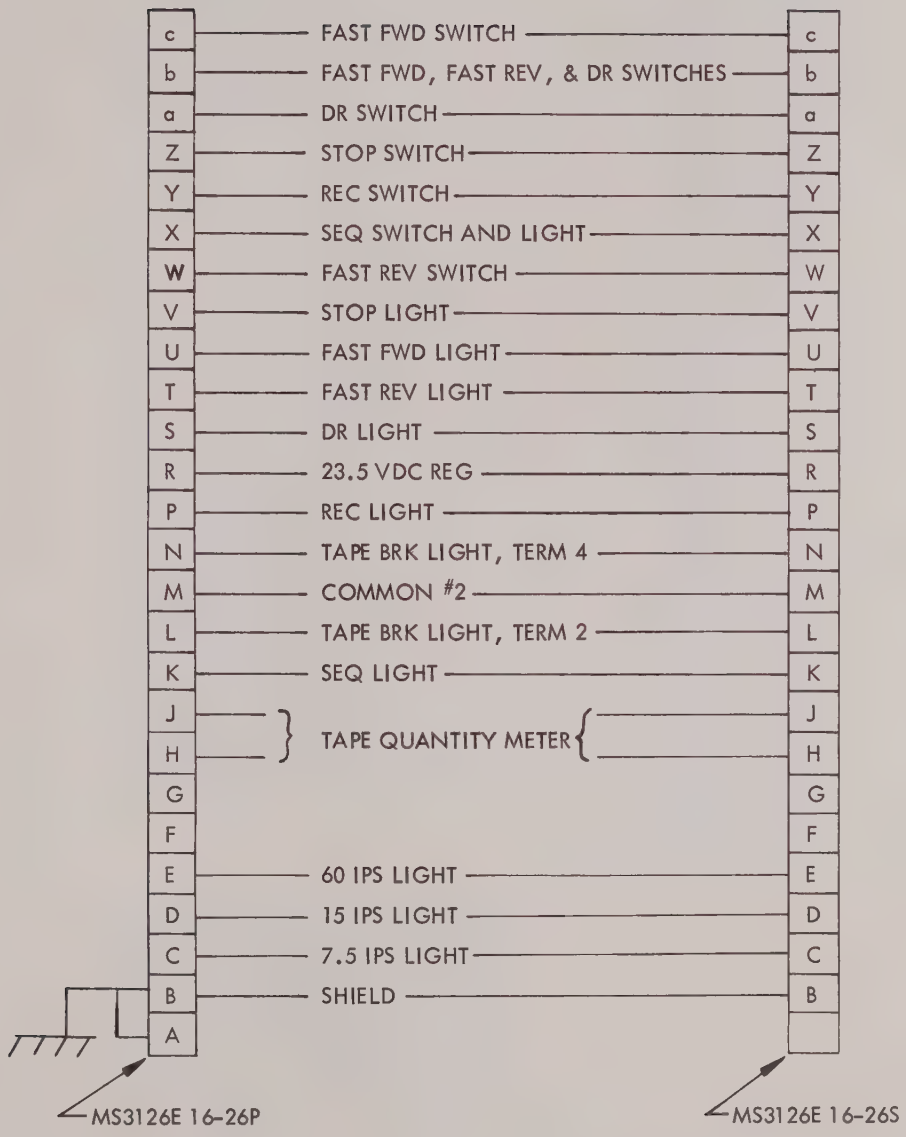


FIGURE 3-4. SCHEMATIC DIAGRAM OF REMOTE CONTROL CABLE

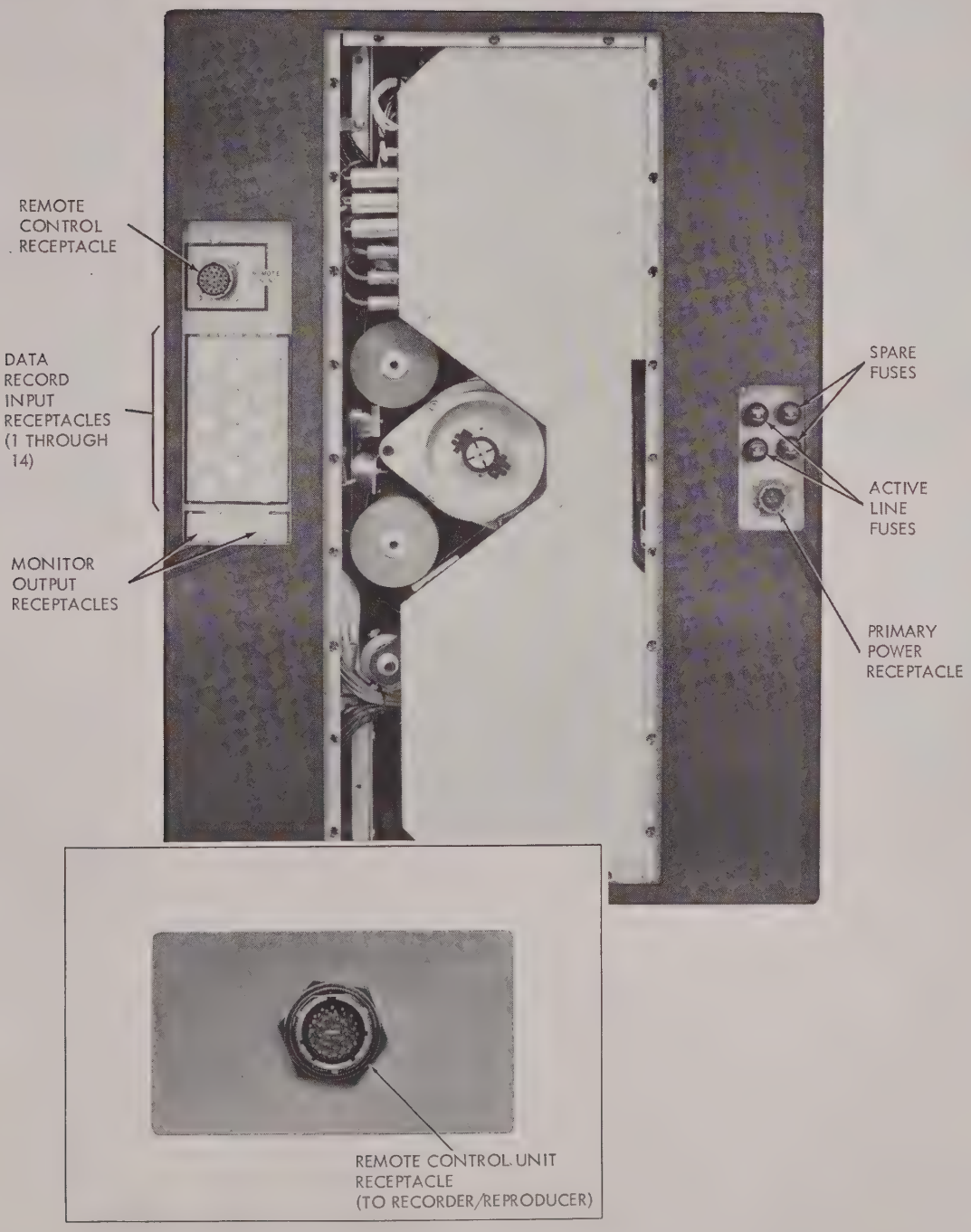


FIGURE 3-5. LOCATION OF CONNECTORS

as shown in Figure 3-3A. The output (monitor) cables should not be longer than 100 feet and should be terminated with 91 ohms. Note that the particular channels that are monitored are selected by the MONITOR SELECT switches on the front of the system (Paragraph 4-22).

3-9. POWER CONNECTION

3-10. The power input receptacle is located at the rear of the system as shown in Figure 3-5. Fabricate a three-wire cable using at least No. 18 AWG wire as shown in Figure 3-3B. The arrangement shown connects the third wire in the power cable to ground at the primary source and to the case of the system at the power input receptacle on the system. Plug the power connector into the power input receptacle. Make sure the POWER switch is at OFF and plug the other end of the power cable into a 115-volt, 60-cps outlet.

3-11. REMOTE CONTROL CONNECTIONS

3-12. Fabricate a cable to connect between the remote control receptacle on the rear of the main unit and the receptacle on the remote control unit as shown in Figure 3-4.

SECTION 4. OPERATION

4-1. GENERAL

4-2. The Winston Model P-4214A Recorder/Reproducer is adjusted, calibrated, and tested at the factory using a 1 volt peak-to-peak input signal level, 3M-915 type magnetic tape, and 1 volt peak-to-peak output level. As long as the same input levels and tape type are used during subsequent operation, recalibration should be required only at periodic intervals due to head wear.

4-3. OPERATING PRECAUTIONS

4-4. In general, the following precautions apply to any direct analog tape recorder from which high accuracy and optimum operation is expected.

4-5. TAPE AND REELS. Use only recommended tape type and precision reels in excellent condition. Tape with dust or dirt on it may lift away from the heads and cause loss of high-frequency signals. Some tapes intended for non-critical use may smear the head gaps and thereby cause a temporary loss of high-frequency response. Worn tape or tape with jagged or uneven edges may cause mistracking and loss of signal. Magnetic tape and reels recommended for use on the Winston Model P-4214A Recorder/Reproducer are listed in Table 4-1.

TABLE 4-1

RECOMMENDED TAPE AND REELS

TAPE	1-inch wide, polyester base, 1.0 mil 3M-915 or equivalent.
REELS	10-1/2-inch NAB precision.

The quality and condition of the tape reels can have a significant effect on the quality of tape recordings and reproduction. Excessive unbalance or misalignment of the reels may cause mistracking or flutter resulting in degradation of tape signals. Any 10-1/2-inch diameter (NAB) precision reels will fit on the recorder; but for optimum performance, the reel recommended in Table 4-1 should be used.

4-6. DIRT AND DUST ACCUMULATION. To avoid contamination of the magnetic tape and tape-handling components, leave the door closed whenever possible. Any accumulated dust or dirt should be immediately removed from the system.

4-7. MAGNETIZATION. It is extremely important that tape handling components, particularly the record and reproduce heads, do not become magnetized. Magnetization of these components can degrade the system signal-to-noise ratio and cause excessive second harmonic distortion. If the following instructions are observed, little difficulty should be encountered in this respect.

a. Do not remove the record amplifier or bias drive module while recording.

b. Do not saturate the magnetic heads with abnormally high input signals or unbalanced pulses.

c. Do not connect an ohmmeter or other dc measuring device across the head windings, since the presence of the dc current may magnetize the head and the current may be sufficient to damage the head windings.

d. Do not allow magnetized components to come in contact or close proximity with the heads or other tape handling components.

e. Do not locate the equipment in strong electrical or magnetic fields.

f. Demagnetize heads daily (after 8 hours of use) or as performance checks indicate.

4-8. CLEANING HEADS. Cleaning the magnetic heads is important, since most tape manufacturers coat their tapes with a lubricant that gradually forms a coating on components it comes in contact with. Therefore, it is recommended that the head stacks be cleaned daily (after eight hours of use). Use a soft, lint-free cloth or Q-tip dampened (not saturated) with trichloroethylene. Be careful not to mar or scratch the surface of the head stacks. Other tape-handling components, including pinch rollers, capstan shafts, and roller guides, should be cleaned frequently as determined by periodic visual inspection.

4-9. OPERATOR CONTROLS AND INDICATORS

4-10. Table 4-2 describes the controls and indicators that require adjustment or observation during normal operation or operational adjustment and calibration and which are accessible without removing any cover plates from the front panel. Figure 4-1 illustrates the location of these controls.

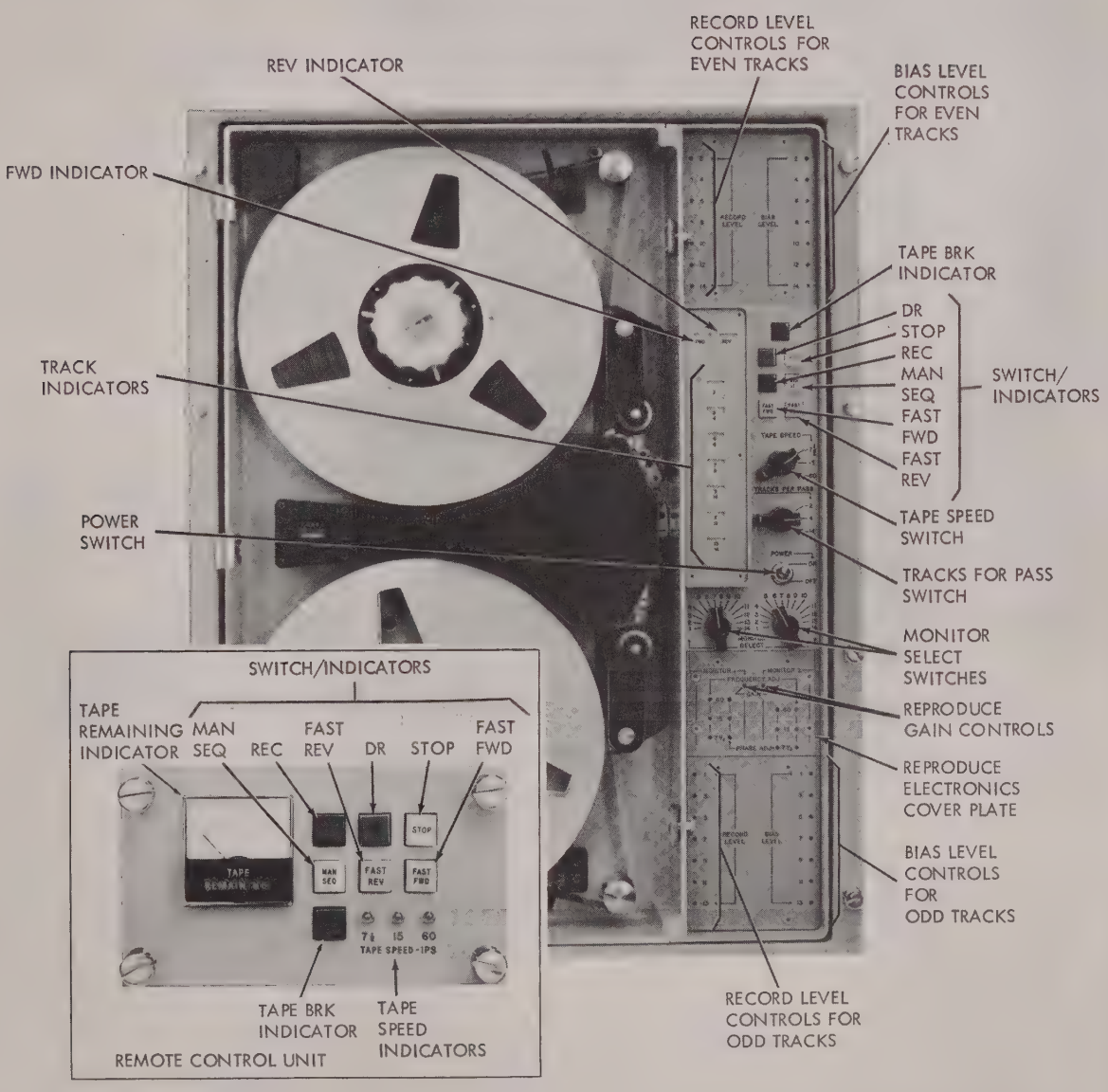


FIGURE 4-1. OPERATOR FRONT PANEL CONTROLS AND INDICATORS

TABLE 4-2.

OPERATOR CONTROLS

NAME & SYMBOL	DESCRIPTION
	----TAPE TRANSPORT----
TAPE SPEED Switch.	A three-position rotary switch used to manually select tape speeds of 7-1/2 , 15, or 60 cps.
TRACKS PER PASS Switch	A three-position rotary switch used to select the number of tracks (2 or 4) to be recorded on each pass in alternating directions, or 14 tracks to be recorded simultaneously.
DR Switch/Indicator	A press-to-operate switch that energizes the tape transport mechanism. Switch is illuminated when the system is in the drive mode of operation.
STOP Switch/ Indicator	A press-to-operate switch that stops the tape transport mechanism and de-energizes the record electronics. Switch is illuminated when capstan motor and tape stop completely.
MAN SEQ Switch/ Indicator	A press-to-operate switch that in record mode reverses tape motion and selects the next set (2 or 4) tape tracks, and in reproduce mode reverses the direction of tape motion. Switch is illuminated when pressed.
REC Switch/Indicator	A press-to-operate switch that places the record electronics in operation. Switch is illuminated when the system is recording.
FAST FWD Switch/Indicator	A press-to-operate switch that starts tape motion in the forward direction at a speed determined by the reel drive motors with the capstan motor not energized. Switch is illuminated while tape is being rewound in forward direction.
FAST REV Switch/Indicator	A press-to-operate switch that starts tape motion in the reverse direction at a speed determined by the reel drive motors with the capstan motor not energized. Switch is illuminated while tape is being rewound in reverse direction.
FWD Indicator	Indicates tape movement in forward direction.
REV Indicator	Indicates tape movement in reverse direction
Track Lamps 1-2 through 13-14 Indicators	Indicate which tracks are being recorded.
Running Time Meter (Hours)	Indicates total time (in hours) tape has moved over heads.

TABLE 4-2. (continued)

NAME & SYMBOL	DESCRIPTION
	----MONITOR----
MONITOR SELECT Switches	14-position rotary switches used to select track output that appears at MONITOR OUTPUT 1 and 2 receptacles at rear of system.
	----POWER----
POWER Switch	Turns primary power to system on or off.
	----RECORD ELECTRONICS----
	(The following are located on the rear panel, Figure 3-5.)
Primary Power Receptacle	Connects primary power to system.
REMOTE CONTROL Receptacle	Connection for remote control cable from remote control unit to recorder/reproducer.
DATA RECORD INPUT Receptacle (1 through 14)	Connections for cables from data input sources (total of 14 connectors), nominal level of 1 volt peak-to-peak. Input impedance is 91 ohms.
MONITOR OUTPUT (1 and 2 Receptacles)	These receptacles are used to connect the reproduce signal to external equipment to monitor or reproduce the two tracks selected by the MONITOR SELECT switches on the front panel. The output should be terminated into 91 ohms.
	(The following controls are accessible directly from the front of the recorder/reproducer, Figure 4-1.)
RECORD LEVEL Control (One control for each of 14 record tracks)	This control adjusts the input signal level to the record amplifier to produce normal record level. It is adjusted at the factory so a nominal input level of 1 volt peak-to-peak produces the normal record level.
BIAS LEVEL Control (One control for each of 14 record tracks)	This control adjusts the record head bias level to a value that results in optimum recording. Adjustment of this control is part of the operational adjustments of the system described beginning in Paragraph 4-27.
	(The following is located on the record amplifier and is accessible after the record electronics cover plate is removed.)
TPI Test Point	This test point is used to measure record head current. The measuring instrument is connected to TPI on the record amplifier and the TPI

TABLE 4-2. (continued)

NAME & SYMBOL	DESCRIPTION
	(common) test point located on the record matrix. The voltage so measured is across a 10-ohm current-monitoring resistor.
	----REPRODUCE ELECTRONICS----
	(The following control is accessible directly from the front panel of the recorder reproducer, Figure 4-1.)
MONITOR LEVEL 1 and 2 Controls	Each of these controls sets the output level of the reproduce electronics signal that appears at the corresponding MONITOR OUTPUT receptacle. The nominal output is 1 volt rms into 91 ohms.
	----REMOTE CONTROL----
TAPE REMAINING Indicator	Indicates amount of tape remaining on feed reel.
REC Switch/Indicator	Same as corresponding item on main unit.
DR Switch/Indicator	Same as corresponding item on main unit.
STOP Switch/ Indicator	Same as corresponding item on main unit.
MAN SEQ Switch/ Indicator	Same as corresponding item on main unit.
FAST REV Switch/Indicator	Same as corresponding item on main unit.
FAST FWD Switch/Indicator	Same as corresponding item on main unit.
TAPE BRK Indicator	Same as corresponding item on main unit.
7-1/2 Indicator	Indicates when tape speed of 7-1/2 ips has been selected at main unit.
15 Indicator	Indicates when tape speed of 15 ips has been selected at main unit.
60 Indicator	Indicates when tape speed of 60 ips has been selected at main unit.

4-11. AUTOMATIC CONTROLS

4-12. Table 4-3 describes all automatic control included in the system as an aid to the operator. These include automatic controls such as end-of-tape sensing, bi-directional sequencing, etc.

TABLE 4-3.

AUTOMATIC CONTROLS

NAME	DESCRIPTION
End-of-Useable Tape Sensing	In 2, 4 or 14 tracks per pass mode, photo cell and associated circuits sense end of useable tape and initiate next pass in reverse direction, or stop operation.
Automatic Sequencing	Stepping switch and associated circuits perform the switching or stop operation initiated by end-of-useable tape sensing circuit. The switching operation includes reversing tape motion and switching record electronics to the next set of channels.
Tape-Break Sensing	A circuit that is completed if the tape breaks or when the supply reel is completely exhausted of tape; the system then goes to the STOP mode.
Belt Change	An electromechanical system that automatically positions the capstan drive belt on the capstan flywheels so the flywheel section with the larger diameter is driven on the supply capstan.
Equalization Control	When the tape speed is changed, the equalizer circuit elements are changed automatically to keep the frequency response of the system within specified limits.

4-13. LOADING AND THREADING

4-14. To load the tape transport, turn the reel hubs fully counterclockwise. Place the full reel of tape on the lower spindle and secure it in place by turning the hub fully clockwise. Thread the magnetic tape into the transport system as shown in Figure 4-2. Attach the loose end of the tape into the upper reel and manually rotate the reel a few turns.

4-15. SPEED SELECTION

4-16. To select a tape speed, rotate the TAPE SPEED switch (Figure 4-1) to the desired position. Although the selection of tape speed can be accomplished only at the local control panel on the system, the selected speed is displayed by an indicator lamp at the remote control panel.

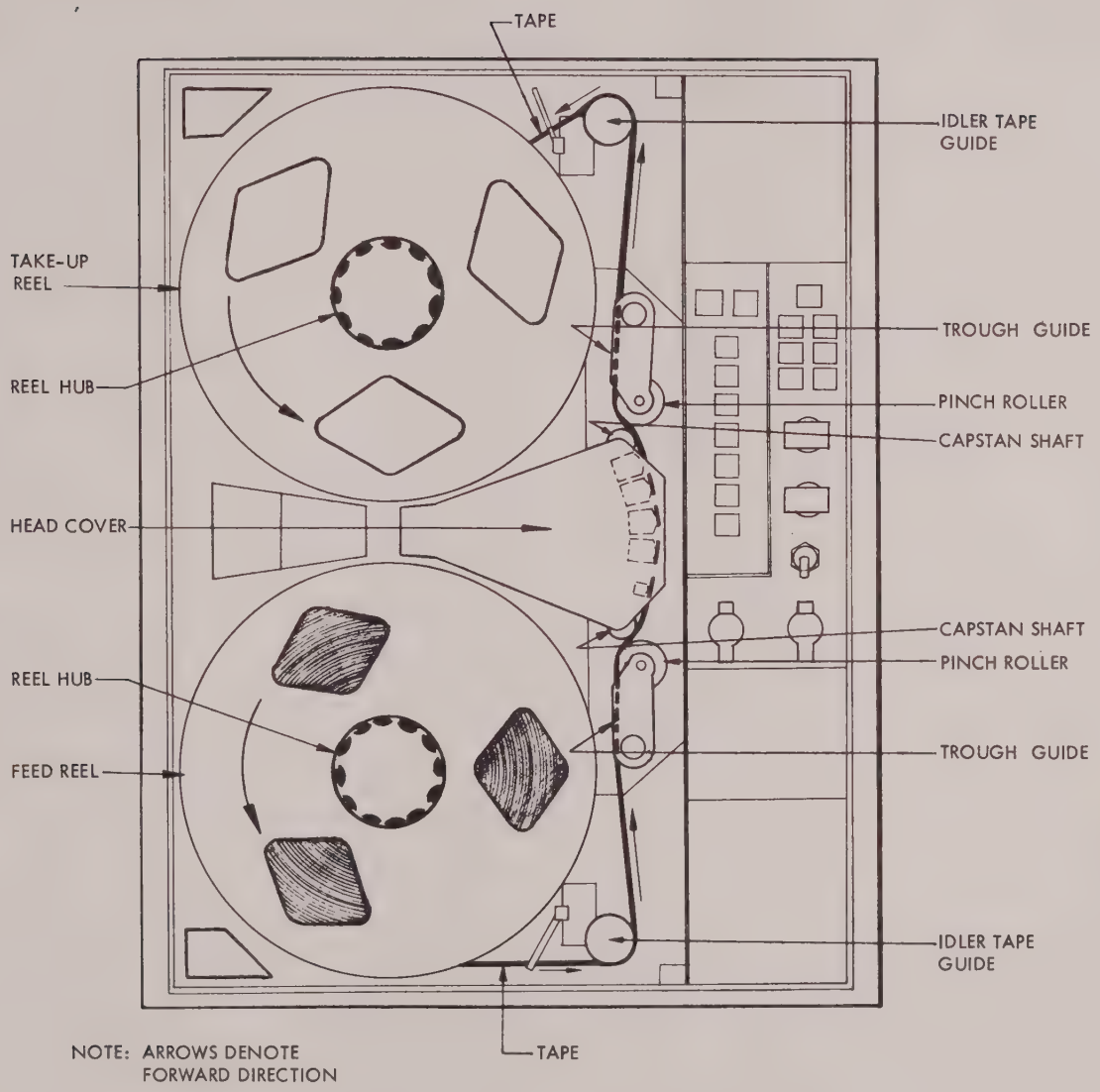


FIGURE 4-2. P-4214A SYSTEM TAPE THREADING DIAGRAM

4-17. SEQUENCE SELECTION

4-18. To select the number of tracks to be recorded on each pass, rotate the TRACKS PER PASS switch (Figure 4-1) to the desired position (2, 4, or 14). If 14 is chosen, only one pass is possible since this is the maximum number of tracks available. When 2 or 4 tracks per pass are selected, the system will record the selected number of tracks on the first pass, automatically reverse direction and record the same input data sources on the next set of tracks, and continue in this manner until the tape is full. While the system is recording, the track lights indicate the tracks actually being filled.

4-19. MODE SELECTION

4-20. Once the tape speed and number of tracks to be recorded have been selected, operation of the system consists merely of pressing the appropriate switch/indicator(s) on the control panel above the TAPE SPEED switch on the local control panel or the corresponding switch/indicator(s) on the remote control panel. The various types of operations are described in the following paragraphs. Refer to Figure 4-1 for location of controls and indicators.

4-21. RECORDING. To record, press the DR switch and then press the REC switch. Either the FWD or REV indicator will light and the tracks being recorded will be shown by the appropriate track indicators. Near the end of the tape (end of useable tape), the direction of motion will reverse and the system will begin recording on the next set of tracks. The direction of tape motion and tracks being recorded will be indicated on the control panel. This sequence will continue automatically until all the available tracks have been recorded or until the sequence is overridden manually, as described in Paragraph 4-22.

4-22. MANUAL OVERRIDE OF AUTOMATIC SEQUENCE. If, while the system is recording, it is desired to manually override the automatic sequence and use the next set of tracks, press and release the MAN SEQ switch. The system will reverse directions and begin recording on the next set of tracks.

4-23. FAST REWIND. To rewind the tape (in either the forward or reverse direction), first press the STOP switch to stop the tape motion. When the STOP switch lights, indicating that both the capstans and reels have completely stopped, press either the FAST FWD or FAST REV switch.

4-24. STOPPING TAPE MOTION. To stop the tape motion, press the STOP switch. All indicator lights will then go out until motion of the capstan and reels has completely stopped. Then the STOP switch will light.

4-25. MONITORING THE RECORDING SIGNAL. While the system is recording, monitoring of the signals can be accomplished only when the tape is moving in the forward direction. A maximum of two tracks can be monitored simultaneously. The tracks to be monitored are selected by the MONITOR SELECT switches. MONITOR SELECT 1 switch selects the output that will be present at the MONITOR OUTPUT 1 receptacle (at the rear of the system). MONITOR SELECT 2 switch selects the output that will be present at the MONITOR OUTPUT 2 receptacle.

4-26. REPRODUCE OPERATION. The tracks to be reproduced are selected by the MONITOR SELECT switches on the control panel. Signals may be reproduced while the tape is moving in either direction. Tape motion is started by pressing the DR switch. The direction of tape motion can be reversed by pressing the MAN SEQ switch. To reproduce tracks recorded when the tape was moving in the reverse direction, press the DR switch and then press the MAN SEQ switch.

4-27. OPERATIONAL ADJUSTMENTS

4-28. Operational adjustments consist of establishing the normal record level, optimizing the bias level, and setting the reproduce output level and equalization. These adjustments are necessary if the input signal level or magnetic tape type is changed. These adjustments should be checked and possibly touched up after each 100 hours of operation to compensate for head wear. Table 4-4 describes the controls that are accessible only after removing the cover plate in front of the reproduce electronics modules and Figure 4-3 illustrates the location of the controls. The following paragraphs describe the adjustment procedures.

NOTE

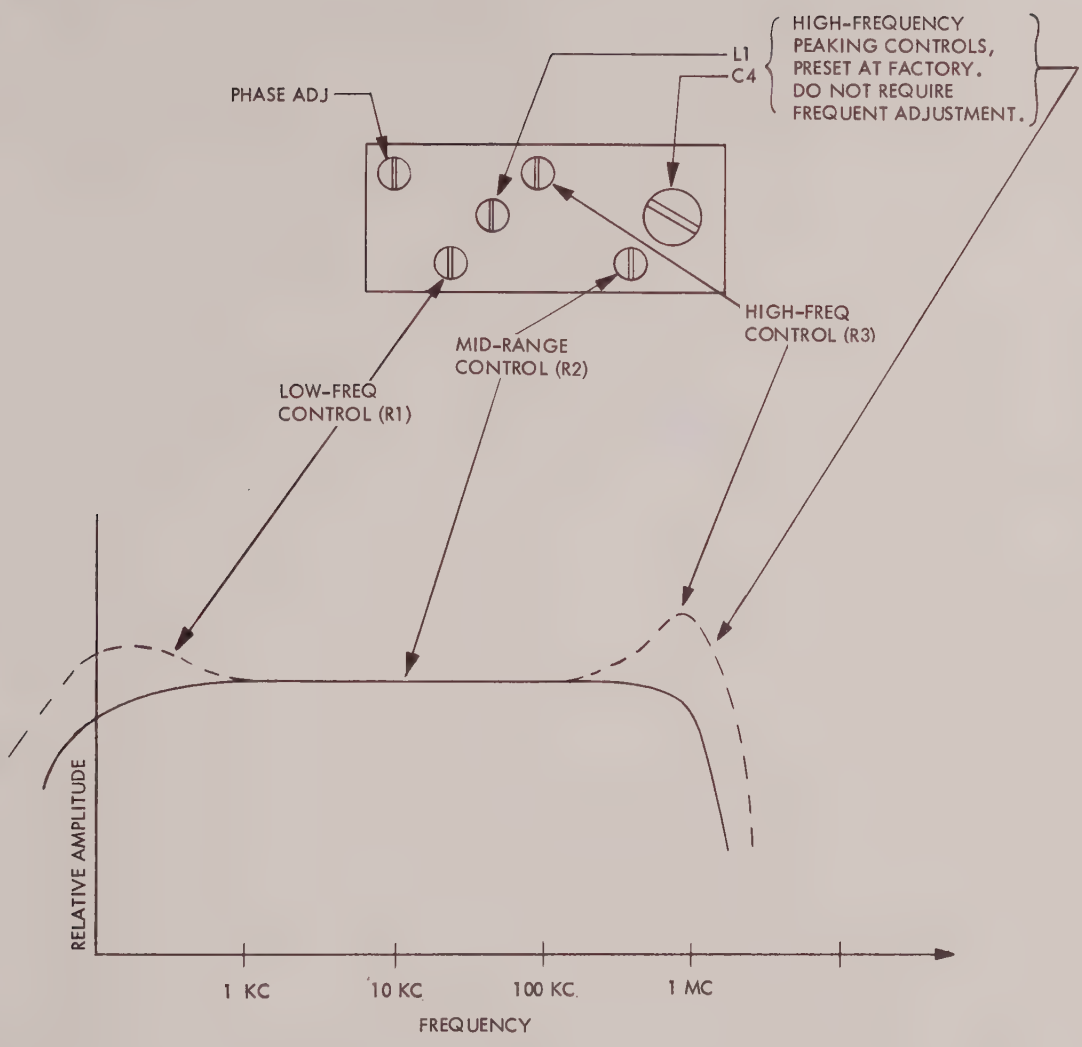
If the system is completely out of adjustment, the bias level should be rough set first, followed by rough setting of the normal record level and reproduce equalization, using the general procedures given below. For final adjustment, the procedures given below should then be repeated in the order given. If only touch-up adjustments are required, simply refer to the applicable procedures in Paragraphs 4-30 through 4-34.

4-29. TEST EQUIPMENT. The test equipment (or equivalent) listed in Table 4-5 is required to perform the operational adjustments. For brevity, the name given in the SHORT NAME column will be used when the test equipment is referred to in the adjustment procedure.

TABLE 4-4.

REPRODUCE ELECTRONICS ADJUSTMENT CONTROLS

NAME & SYMBOL (As marked)	DESCRIPTION
	----REPRODUCE ELECTRONICS----
	(The following are located on the reproduce equalizer module, Figure 4-3, and are accessible after the reproduce electronics cover plate is removed.)
Low-Frequency Control (R1)	This control sets the low-frequency response of the direct record/reproduce system. (See reproduce equalization adjustments beginning with Paragraph 4-32.)
Mid-Range Control (R2)	This control sets the mid-range frequency response of the system. (See reproduce equalization adjustments beginning with Paragraph 4-32.)
High-Frequency Control (R3)	This control sets the nominal output of the system at the high-frequency edge of the passband. (See reproduce equalization adjustments beginning with Paragraph 4-33.)
High-Frequency Peaking Controls (C4 and L1)	These controls set the response of the reproduce equalizers for peak output at the highest frequency within the passband. These controls are normally preset at the factory and do not require frequent adjustment.
High-C Switch (S1)	This three-position switch is used to select a capacitor that will compensate for any dip or bow in the frequency response curve between 70 kc and 1 mc at 60 ips. See reproduce equalization adjustments beginning with Paragraph 4-32.
Low-C Switch (S2)	This three-position switch is used to select a capacitor that will compensate for a dip or a bow in the frequency response curve from 400 cps to 1.5 kc. (See reproduce equalization adjustments beginning with Paragraph 4-32.)



EQUALIZATION FREQUENCIES

TAPE SPEED	REFERENCE FREQUENCY	MID-RANGE FREQUENCY	HIGH FREQUENCY	LOW FREQUENCY	SQUARE WAVE
60 ips	10 kc	100 kc	1.0 mc	400 cps	10 kc
15 ips	5 kc	25 kc	225 kc	300 cps	5 kc
7-1/2 ips	5 kc	12 kc	100 kc	300 cps	5 kc

FIGURE 4-3. LOCATION OF REPRODUCE ELECTRONICS ADJUSTMENT CONTROLS

TABLE 4-5.

TEST EQUIPMENT

NO REQ'D	TYPE OF TEST EQUIPMENT (OR EQUIVALENT)	SHORT NAME	USE
1	Signal Generator, Hewlett Packard HP 650-A	Sine Wave Oscillator	To provide sine wave test input signals for operational adjustments.
1	Sweep Oscillator, Tel Instrument Corporation Model 1105	Sweep Oscillator	To provide test input signals, periodically varying in frequency for operational adjustments.
1	Square Wave Oscillator, Hewlett Packard HP 211A	Square Wave Oscillator	To supply square wave test input signals for amplitude and phase equalization adjustment.
1	Oscilloscope, Tektronix Model 545A	Oscilloscope	To provide visual display of wave forms when operator is making operational adjustments.
1	RMS Voltmeter, Hewlett Packard HP 400L	VTVM	To measure input and output signals.
1	Wave Analyzer, Hewlett Packard HP 310A	Wave Analyzer	To measure the third harmonic content of output signal to verify that operational adjustments have been made correctly.

4-30. RECORD ADJUSTMENTS. For a specified brand and type of magnetic tape and a given amount of bias current, the record level determines the amount of distortion in the recording. The principal distortion resulting from magnetic tape overload is the third harmonic component and it rises with increasing record current. The relationship between record current and distortion is not linear, except at very low levels of distortion. Once a level of 2 or 3 percent harmonic distortion has been reached, distortion increases very rapidly with further rises in record current. Hence, from the distortion viewpoint, it is better to record at low level. However, recording at too low a level adversely affects the signal-to-noise ratio of the system. For these reasons it is necessary to determine the normal record level for a given input voltage and signal-

to-noise ratio. For the Winston Model P-4214A Recorder/Reproducer, the normal record level is defined as the level of record current that, upon reproduction, results in a maximum output at 1 mc at 60 ips with a total midband harmonic distortion of not more than 3 percent.

4-31. The following procedure is used to establish the proper record and bias levels. Note that there are separate record level and bias level adjustments for each of the 14 record tracks.

a. Thread a reel of clean, bulk-degaussed magnetic tape on the transport.

b. Set the TAPE SPEED switch to 60 ips.

c. Set the TRACKS PER PASS switch to 14.

d. Set one of the MONITOR SELECT switches to 1.

e. Connect the test equipment as shown in Figure 4-4 with the sweep oscillator connected to the DATA RECORD INPUT 1 receptacle. Connect the oscilloscope to the MONITOR OUTPUT receptacle corresponding to the switch used in Step d above.

f. Adjust the output level of the sweep oscillator to the same value as that of the data to be recorded on track 1.

g. Operate the system to record (Paragraph 4-21).

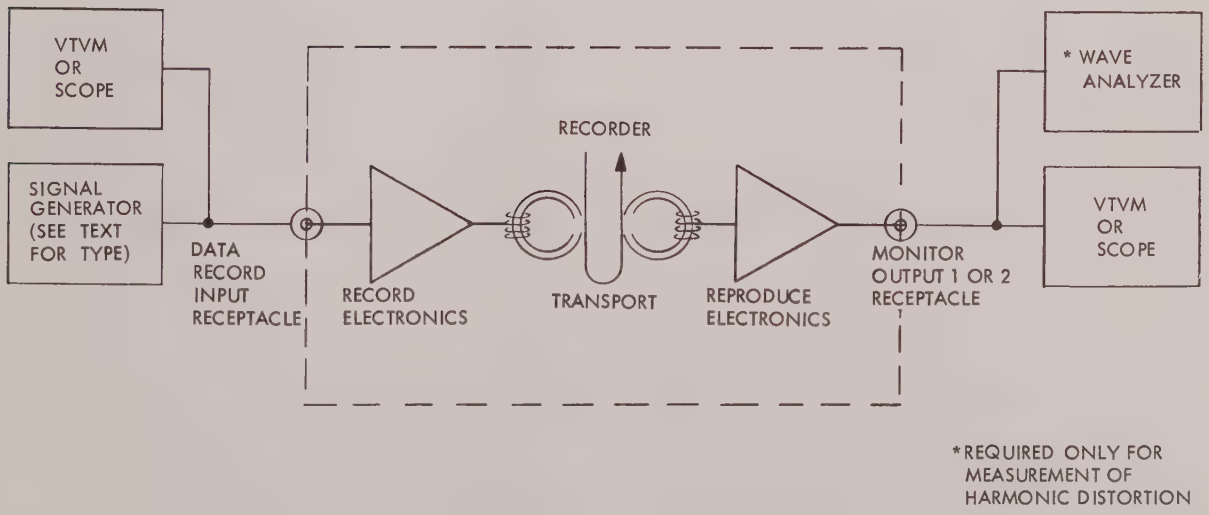


FIGURE 4-4. TEST SETUP FOR RECORD AND REPRODUCE ADJUSTMENTS AND MEASUREMENT OF HARMONIC DISTORTION

h. Adjust the RECORD LEVEL control for track 1 so the output displayed on the oscilloscope just begins to decrease at 1 mc.

i. Adjust the BIAS LEVEL control (Figure 4-3) for minimum drop-off at high frequencies and minimum variation (ripple) in amplitude at low frequencies.

This completes the adjustment of the record electronics for one track.

j. Repeat steps e through i for each of the remaining 13 tracks. For each adjustment, connect the sweep oscillator to the DATA RECORD INPUT receptacle for the track being adjusted and set the MONITOR SELECT switch to the position corresponding to this track. Note that the output level of the sweep oscillator must be adjusted to the level of the data to be recorded on each separate track.

OPERATOR'S NOTE

Note that two physical limitations are present when attempting step i. At low bias levels the distribution of the field of the record head gap has two maxima, each located at an edge of the gap. Since the record head gap is larger than the reproduce head gap, the interference wavelengths on the tape will occur in the 100-kc region. With low bias levels, the recording made by the leading edge of the gap will not be sufficiently demagnetized when that part of the tape goes by the gradient of the trailing edge of the gap. The resulting interference will then be observable at low bias levels. At higher bias levels, the self-demagnetization from the finite flux gradient will depress the high-frequency amplitudes and will tend to erase the recording made by the leading edge. The adjustment of Step i then sets the proper bias level, which is actually a compromise between (1) distortion and high-frequency demagnetization, and (2) midband ripple.

4-32. REPRODUCE EQUALIZATION ADJUSTMENTS. Any one of the 14 recorded tracks may be reproduced through either set of reproduce electronics. To achieve the full performance capabilities of the system, the reproduce equalization must be adjusted as shown by the solid response curve in Figure 4-5. These adjustments must be made for each speed at which monitoring or reproduce operation is to take place.

4-33. Reproduce Frequency Equalization And Level Adjustments. To make the reproduce frequency equalization and level adjustments, first remove the reproduce electronics cover plate (Figure 4-1), and then proceed as follows:

a. Set up the test equipment as shown in Figure 4-4, using the sine wave oscillator as the signal input.

b. Adjust the level of the sine wave oscillator to that of the data to be recorded on the particular track being monitored.

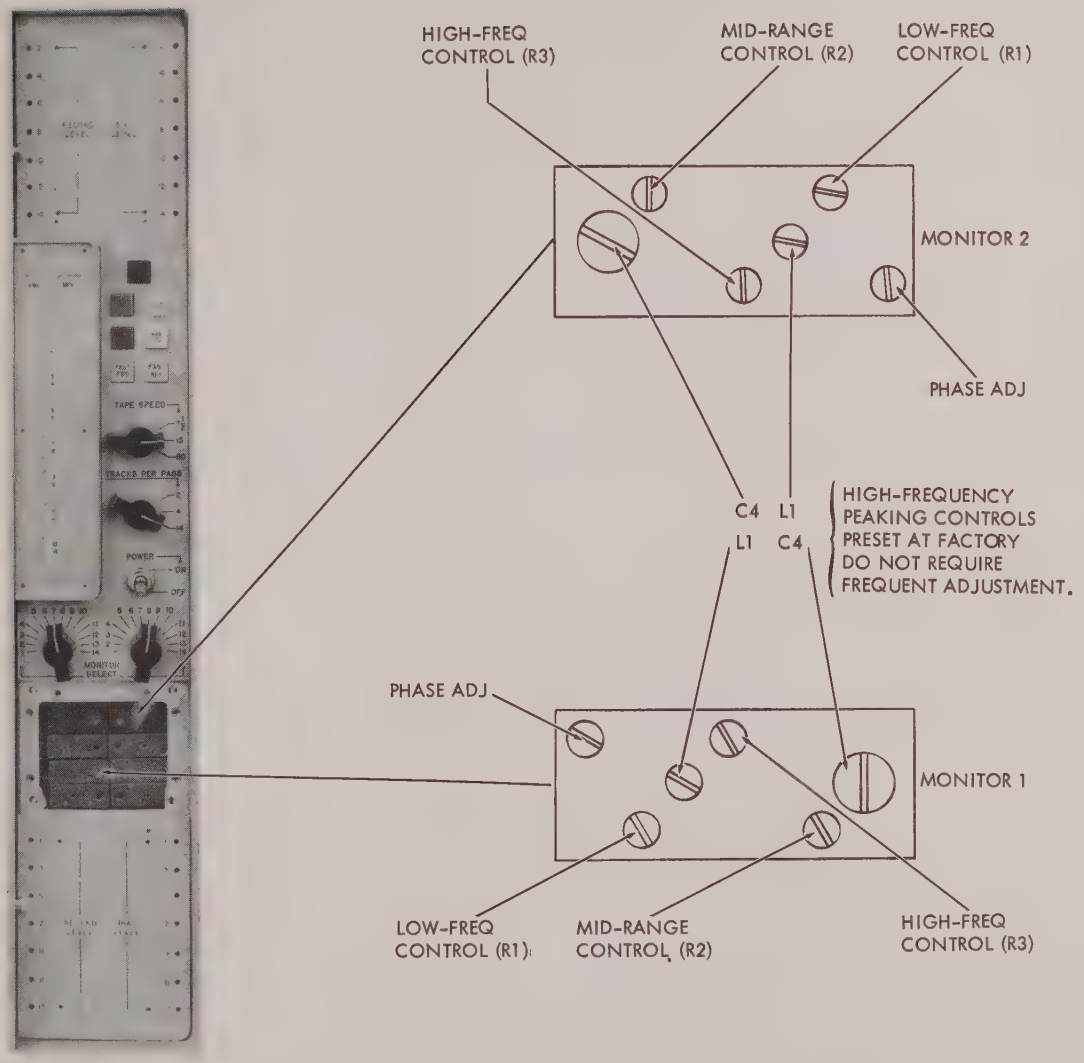


FIGURE 4-5. FUNCTION OF EQUALIZER CONTROLS

c. Set the TAPE SPEED switch to the desired position.

d. Set the TRACKS PER PASS switch to 14.

e. Thread a reel of clean, bulk-degaussed tape on the transport.

f. Set the frequency of the sine wave oscillator to the LOW FREQUENCY listed in Figure 4-5.

g. Operate the system to record (Paragraph 4-21).

h. Adjust the MONITOR LEVEL control (Figure 4-1) for an output level of 1 volt peak-to-peak.

i. While keeping the output of the sine wave oscillator constant, slowly sweep the frequency of the oscillator to 2 kc above the LOW FREQUENCY listed in Figure 4-5. Adjust the low-frequency control, R1, (Figures 4-3 and 4-5) on the appropriate equalizer so the amplitude of all frequencies within this range are within ±3 db of the output obtained in step h.

j. Set the sine wave oscillator to the MID-RANGE FREQUENCY listed in Figure 4-5. Adjust the level of the oscillator to that of the data to be recorded on the track being monitored.

k. While recording, monitor the output and adjust the mid-range control, R2, (Figures 4-3 and 4-5) on the appropriate equalizer so the output is 1 volt peak-to-peak.

l. Set the sine wave oscillator to the HIGH FREQUENCY listed in Figure 4-5. Adjust the level of the oscillator to that of the data to be recorded on the track being monitored.

m. While recording, monitor the output and adjust the high-frequency control, R3, (Figures 4-3 and 4-5) on the appropriate equalizer so the output is 1 volt peak-to-peak.

n. While maintaining the input at a constant level, sweep the sine wave oscillator frequency slowly through the passband and observe the output level. If there is a dip or bow in the response curve in the high range (i.e., 70 kc to 1 mc at 60 ips), set the HIGH C control, S1, on the side of the equalizer to eliminate this dip or bow. If there is a dip or bow in the frequency curve in the low range (i.e., 400 cps to 1.5 kc), adjust the LOW C control, S2, on the side of the equalizer to eliminate this dip or bow.

NOTE

Switches S1 and S2 are preset at the factory and normally do not require further adjustment. If adjustment of these controls should become necessary, the equalizer module must be removed to gain

access to S1 and S2. Always turn off the power before unplugging any of the electronic modules.

o. Check the frequency response over the entire passband and make any necessary trimming adjustments, as described in steps i, k, and m above.

4-34. REPRODUCE PHASE EQUALIZATION ADJUSTMENT. To make the reproduce phase equalization adjustment, proceed as follows:

a. Set up the test equipment as shown in Figure 4-4, using the square wave oscillator as the signal generator.

b. Set the square wave oscillator to the SQUARE WAVE frequency listed in Figure 4-5 and the level to that of the data to be recorded on the particular track being monitored.

c. Record the square wave and observe the reproduced output on the oscilloscope.

d. Adjust the PHASE ADJ control on the appropriate equalizer (Figure 4-3) for best square wave output. It may be necessary to touch up the high-frequency adjustment (Paragraph 4-33, step m) to obtain the best square wave response. The equalization adjustments (Paragraph 4-33) affect the square-wave response as follows:

Phase Adj	Pre-ring, post-overshoot, and tilt.
High-Freq Control (R3)	Controls the high-frequency ringing level.
Mid-Range Control (R2)	Control the low-frequency tilt.

4-35. MEASUREMENT OF HARMONIC DISTORTION. The adjustment procedures given in Paragraphs 4-31 through 4-34 should result in a harmonic distortion of less than 3 percent for a maximum record level. To verify that this is true, the following procedure may be used to measure the harmonic distortion.

a. Set up the test equipment as shown in Figure 4-4, using the sine wave oscillator as the signal generator. Also connect the wave analyzer shown in Figure 4-4.

b. Set the sine wave oscillator for an output of 1 volt peak-to-peak at 10 kc.

c. Set the wave analyzer for measurement of the third-harmonic content of the input signal (i.e., 30 kc).

d. Record the 10-kc input signal. Observe the third-harmonic content on the wave analyzer. The third harmonic content should be less than 3 percent.

4-36. RUNNING TIME METER

4-37. To indicate the total time the tape has moved past the heads, a running time meter is located between the reels on the left side of the front panel. It indicates 9999.9 hours full scale.

4-38. CAPSTAN DRIVE BELT CARE AND REPLACEMENT

4-39. When properly handled, the capstan drive belt used in the Winston P-4214A need be replaced only after each 500 hours of running time. Refer to Section 5 for information on belt care, inspection, and replacement procedure.

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